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## **Job Quality and Wages in Duopsony\***

Jürgen Figerl and Thomas Grandner<sup>‡</sup>

Working Paper No. 121, June 2008

**Abstract** — *In a simple oligopsonistic model, firms compete for labour through wages and job qualities. We modify the product market model developed by Vandenbosch/Weinberg 1995 and apply it to the job market with jobs being defined by two vertically differentiated non-wage characteristics. Workers differ in their valuation of these two characteristics but do not differ in their productivity. In equilibrium firms offer different wages and differ in only one of these non-wage characteristics. Whereas our labour market model is based on firms, we apply subclasses according to the UK SIC(2003) in our empirical analysis. When comparing subclasses within selected sectors (WERS) we found evidence that firms compete in both wages and job qualities.*

**Keywords:** Oligopsony; Wage Differentiation; Non-wage Competition

**JEL-Classification:** J30

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# 1 Introduction

Simple perfect competition labour market models can hardly describe typical real labour market situations. The assumption of homogeneous workers and working places is evidently disproved. Wage dispersion is a robust phenomenon. Recently models of imperfect competition, borrowed from Industrial Organization, are used to incorporate features of oligopsony, that is the incorporation of wage setting power by firms (for a survey see Bhaskar, Manning and To 2002). Typical features of such models are wages lower than in competitive markets, employment increasing effects of minimum wages or wage dispersion (for example Bhaskar and To 2003).

Work places (and wage differentiation) are usually coupled with differentiated non-wage job characteristics. These differences can be characterized vertically or horizontally. Jobs are differentiated vertically if all workers agree in the ordering of that characteristic. Training possibilities or job security are probably examples for vertical job characteristics. These characteristics are often connected with the term *quality*. Workers do not agree on the ordering of a horizontal job characteristic. Geographic location or hours to work may be examples for horizontal job characteristics.

Important is that in most cases these characteristics are not fixed for the firms. To the contrary, firms can design their work places and can compete not only by the wage rate but also by non-wage job characteristics. Firms may be able to improve their profits by setting these characteristics in a strategic way. E.g. several studies for the non-profit sector have shown that non-profit employers offer lower wages but better working conditions. A good survey is given by Powell and Steinberg (2006), Chapter 7 for example. Almond and Kendall (2000) show for the United Kingdom, by comparing objective measured job characteristics, that non-profit workers receive higher flexibility in work arrangements as well as higher levels of training but they have to do more unpaid overtime than workers in the for-profit and government sector. Preston (1990) pointed out that these offers of flexibility may be an explanation for the overrepresentation of women in the non-profit sector. Thus there is evidence that non-profit firms do compete for workers against for-profit firms by offering for example more flexibility in the work schedule.

In the industrial organization literature a huge number of articles analyze the reasons for (product-)differentiation. Beginning with Hotelling (1929) who argued that a considerable differentiation is unlikely to be observed, because firms competing for market shares will supply products that are favourable for the median buyer.

This *principle of minimal differentiation* was disputed from the beginning (for early contributions see Lerner and Singer (1937) or Smithies (1941)). Only in 1979 d'Aspremont, Gabszewicz and Thisse detected an error in Hotelling's argument. They showed that in Hotelling's *linear city* model with linear transportation costs no price equilibrium exists and therefore the product differentiation stage is not well defined. They found that with quadratic transportation costs, a price equilibrium exists and maximal differentiation is the best firms can do in a *linear city* (given evenly distributed buyers). To differentiate the characteristic as large as possible soften price competition. In general two opposite effects arise with product or job differentiation. The first effect is the market size effect, emphasized by Hotelling. The second effect accentuates monopolization and is called the strategic effect (Tirole 1988). Firms differentiate their products to avoid price competition.

There exist several papers in Industrial Organization analyzing situations with more than one characteristic. Neven and Thisse (1990) work with two characteristics, a vertical and a horizontal one. Vandenbosch and Weinberg (1995) analyze two vertical characteristics and Irmen and Thisse (1998) examine a situation with two or more horizontal characteristics. All three papers found a common solution with maximal differentiation in one of the characteristics and no differentiation with the other characteristic (at least one of the equilibria is of the described type). Thus both effects described above are working in these models. Firms will differentiate in one of the characteristics to avoid price competition and, at the same time, will choose the second characteristic in a way to favour the median buyer.

In this paper we reinterpret Vandenbosch and Weinberg (1995) in an oligopsonistic labour market view. Firms offer jobs which are characterized by two non-wage characteristics. Both characteristics are vertically differentiated, that means that in the view of all potential workers there exist an optimal specification of the job (we will call this the qualities of the job). But workers differ in their willingness to substitute these qualities for wage. Firms may offer differentiated jobs to discriminate between workers who call for high quality and workers who are willing to accept lower quality in exchange for higher wages. In equilibrium wages will be differentiated and, as usual in oligopsonistic markets, wages will be lower than in a competitive labour market. In addition a social planner would offer higher average qualities than firms will offer in the market process. In equilibrium firms will differentiate jobs only in one of the (two) characteristics.

Bhaskar and To (2003) present an oligopsonistic model, where workers with the same productivity earn differentiated wages. They analyze a model, based on a product market model by Salop (1979), with one horizontal job characteristic in a *circular city*. To get differentiated wages they need heterogeneous employers in the sense that the marginal product of labour varies between the employers. Firms do not choose the differentiated job characteristic, it is given by the model design and is no issue in their paper. In our model the marginal product of labour is the same in all (both) firms, wages are differentiated because firms choose to differ in the non-wage job characteristics.

To get a feeling on the empirical relevance of our argument we use the dataset WERS (Workplace Employment Relations Survey<sup>1</sup>) to compare non-wage characteristics between several subclasses (UK SIC(2003)) of the economy. WERS is an employee-employer data. Job characteristics are measured on an ordinal, subjective basis. By comparing subclasses, using a Mann-Whitney-Test to test for differentiated populations of the subclasses, we found some evidence that firms do compete in one of the job characteristics in order to retain and attract employees.

## 2 Model

In our simple model workplaces are vertically differentiated by characteristics  $a$  and  $b$ , with  $a \in [a_{\min}, a_{\max}]$  and  $b \in [b_{\min}, b_{\max}]$ . Both characteristics measure quality. Two firms offer jobs with characteristics  $(a_1, b_1)$  and  $(a_2, b_2)$  (each firm offer only one bundle). Both firms can choose these characteristics without bearing any costs.

Figure 1 shows three possible job specifications of firm 1. In point  $A$  firm 1 is offering

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<sup>1</sup>Kersley, Alpin, Forth, Bryson, Bewley, Dix and Oxenbridge (2006) give a description of this survey.

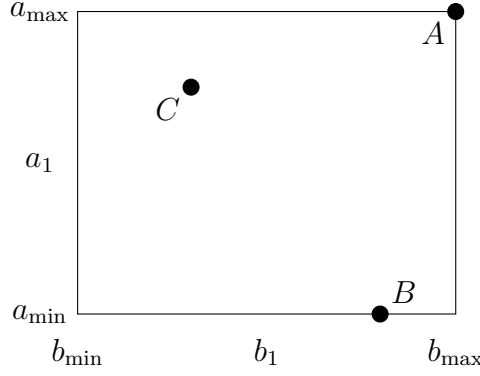


Figure 1: Quality of workplace in firm 1

both characteristics at the highest quality (given the wage, all workers would prefer this specification). In  $B$  characteristic  $a$  is offered at its lowest quality, while characteristic  $b$  is offered at an intermediate level. In  $C$  the quality of both characteristics lies in the intermediate range. Keep in mind, that the ranges of characteristics  $a$  and  $b$  can differ in principle, but we will simplify the model by forcing the same range for both characteristics. The effects of loosening this assumption will be discussed in short at the end of this section.

Workers labour supply is completely inelastic, but they differ in their willingness to substitute high quality for wage. This willingness is represented by  $t_a^i$  and  $t_b^i$ , with  $i$  being the index for workers. Workers differ only in these valuation parameters, which are independently and uniformly distributed over the interval  $[0, 1]$ . Given the same wage for all specifications, whether a worker prefers specification  $B$  over specification  $C$  in Figure 1 depends on his or her valuation parameters  $t_a^i$  and  $t_b^i$  ( $A$  is the best configuration for all workers, but comparing  $B$  to  $C$ , individual workers can disagree). The utility a worker  $i$  receives from a job  $j$  is given by  $w_j + t_a^i a_j + t_b^i b_j$ . We assume that this utility is high enough that all workers will supply their labour.

Worker  $i$ , who is characterized completely by  $[t_a^i, t_b^i]$ , is indifferent to work in firm 1 or in firm 2 if

$$w_1 + t_a^i a_1 + t_b^i b_1 = w_2 + t_a^i a_2 + t_b^i b_2 \quad (1)$$

(In what follows, we will suppress the index  $i$ ).

Given (1) we can describe all workers who are indifferent to work in firm 1 or 2, given wages and non-wage characteristics, by the indifference line

$$t_a = \frac{w_2 - w_1}{a_1 - a_2} - \frac{b_1 - b_2}{a_1 - a_2} t_b \quad (2)$$

for all  $a_1 \neq a_2$ . (If  $a_1 = a_2$  we can invert the indifference line. In that case we need  $b_1 \neq b_2$ . If firms do not differ in at least one characteristic, an indifference line is not defined, all workers prefer to work in the firm offering the higher wage.)

Figure 2 shows such an indifference line (each point in the  $[t_a, t_b]$  space characterizes exactly one worker). Assume  $w_2 > w_1$ , all workers below the indifference line will work in firm 2, all worker above the line in firm 1.

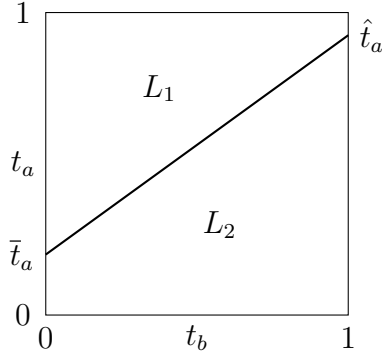


Figure 2: Indifference line

Only if both firms pay the same wage, the indifference line goes through the point  $(0,0)$ . (The decision of the worker characterized by the point  $(0,0)$ —he or she is the only worker who does not care about quality in both characteristics—is based on wages only). The intercept of the indifference line depends negatively on the quotient of the wage difference and the quality difference in characteristic  $a$ .

The slope of the indifference line is positive if each firm has an advantage in one of the characteristics (Vandenbosch and Weinberg (1995) call this *asymmetric characteristics competition*). If firm 1 offers higher quality in characteristic  $a$ , firm 2 offers higher quality in characteristic  $b$  and vice versa. The slope of the indifference line is less than one if the difference between the offered characteristic  $b$  is smaller than the difference between the offers in characteristic  $a$ .

The slope of the indifference line is negative if one firm offers higher quality in both characteristics (*dominated characteristics competition*). In this case if wages are the same in both firms, all workers will work in the firm with the higher quality of workplaces. For a positive quantity of labour the firm with the lower quality has to offer a higher wage than its competitor.

We analyze a two stage game. In stage 1 firms decide simultaneously over the quality of their workplaces ( $a_1, b_1$  respectively  $a_2, b_2$ ). Firms can offer any quality without costs. In stage 2 firms simultaneously select their wages. Given the quality of the workplaces and the wages, workers are allocated according their valuation parameters. We use subgame-perfection in pure strategies as equilibrium concept. Therefore, we start to analyze stage 2, to find equilibrium wages for all quality variations. Given the wage equilibrium we can then analyze the quality setting stage.

This game has several equilibria. In what follows, we will derive the unique equilibrium for  $a_{\max} = b_{\max} = \bar{c}$  and  $a_{\min} = b_{\min} = \underline{c}$  (so Figure 1 will be a square). With different ranges for the characteristics additional equilibria occur. We will discuss these equilibria at the end of the section. In the empirical part of the paper (Section 3) the characteristics are measured by a subjective ordinal measure, therefore the meaning of the range of a characteristic is nonspecific in some respect.

Let us start with an indifference line as in Figure 2. The indifference line intersects both vertical boundaries within the interval  $[0,1]$ . The slope of the indifference line

$-(b_1 - b_2)/(a_1 - a_2)$  must be in the interval  $[-1,1]$ .

**Assumption 1** :  $a_1 > a_2$

In this case the indifference line intersects the left vertical axis only if  $w_2 > w_1$  and all workers below the indifference line will work in firm 2, all workers above the indifference line will work in firm 1.

**Assumption 2** :  $0 \leq \bar{t}_a = \frac{w_2 - w_1}{a_1 - a_2} \leq 1$

The indifference line intersects the left boarder within  $[0,1]$ .

**Assumption 3** :  $0 \leq \hat{t}_a = \frac{w_2 - w_1}{a_1 - a_2} - \frac{b_1 - b_2}{a_1 - a_2} \leq 1$

The indifference line intersects the right boarder line within  $[0,1]$ .

Labor assigned to firm 2 is given by the area under the indifference line.

$$L_2 = \bar{t}_a + \frac{(\hat{t}_a - \bar{t}_a)}{2} = \frac{w_2 - w_1}{a_1 - a_2} - \frac{b_1 - b_2}{2(a_1 - a_2)} \quad (3)$$

Labor assigned to firm 1 is

$$L_1 = 1 - L_2 \quad (4)$$

These equations show that the firm specific labour supply functions are upward sloping, typical for monopsonistic or oligopsonistic models.

## 2.1 Wage Competition

In stage 2 firms will set the wages to maximize profit. We allow for interfirm wage differentiation, within a firm all workers receive the same wage. We apply a very simple production function, the marginal productivity of all workers is the same and constant. Firm  $i$ 's profit is given by

$$\pi_i = (p - w_i)L_i \quad (5)$$

with  $p$  is the common constant value of the (marginal) product of labour. Firms choose wages to maximize their profit.

$$\frac{\partial \pi_i}{\partial w_i} = -L_i + (p - w_i) \frac{\partial L_i}{\partial w_i} = 0 \quad (6)$$

We get the standard upward sloping reaction functions for firm 1 and 2

$$w_1 = \frac{p + w_2 - (a_1 - a_2) - \frac{b_1 - b_2}{2}}{2} \quad \text{and} \quad w_2 = \frac{p + w_1 + \frac{b_1 - b_2}{2}}{2} \quad (7)$$

Both reaction functions are increasing with slope  $\frac{1}{2}$ .

The intersection of the reaction functions gives the equilibrium in the wage game.

$$w_1 = p - \frac{2(a_1 - a_2)}{3} - \frac{b_1 - b_2}{6} \quad (8)$$

$$w_2 = p - \frac{a_1 - a_2}{3} + \frac{b_1 - b_2}{6} \quad (9)$$

Note that  $w_1$  decreases with the qualities ( $a_1$  and  $b_1$ ) of firm 1's job offer and increases with the qualities of the competitor. On the other hand  $w_2$  increases with firm 2's quality  $a_2$  and decrease with  $b_2$ , while  $w_2$  reacts in the opposite direction with the qualities of firm 1.

The difference between firm 1's and firm 2's wage is

$$w_2 - w_1 = \frac{(a_1 - a_2) + (b_1 - b_2)}{3} \quad (10)$$

Using (4) and (3) we get

$$L_1 = \frac{2}{3} + \frac{b_1 - b_2}{6(a_1 - a_2)} \quad \text{and} \quad L_2 = \frac{1}{3} - \frac{b_1 - b_2}{6(a_1 - a_2)} \quad (11)$$

Profits are given therefore by

$$\pi_1 = (a_1 - a_2)L_1^2 \quad \text{and} \quad \pi_2 = (a_1 - a_2)L_2^2 \quad (12)$$

## 2.2 Choice of quality

Given the solution of stage 1 we can now analyze the non-wage competition stage given assumption 1 to 3. Both firms can choose the two characteristics  $a$  and  $b$  within the boundaries  $[\underline{c}, \bar{c}]$ . They will do this so as to maximize profit. We can describe the firms' choices by describing  $\frac{d\pi_i}{dc_i}$ , where  $c_i$  stands for the two characteristics  $a$  and  $b$ .

$$\frac{d\pi_i}{dc_i} = -\frac{dw_i}{dc_i}L_i + (p - w_i) \left( \frac{\partial L_i}{\partial c_i} + \frac{\partial L_i}{\partial w_i} \frac{dw_i}{dc_i} + \frac{\partial L_i}{\partial w_j} \frac{dw_j}{dc_i} \right) \quad (13)$$

Using (6) we can describe the derivative by

$$\Rightarrow \frac{d\pi_i}{dc_i} = \frac{\partial L_i}{\partial c_i} + \frac{\partial L_i}{\partial w_j} \frac{dw_j}{dc_i} \quad (14)$$

The first effect is called market size effect, while the second effect is called the strategic effect by Tirole (1988).

Evaluating these derivatives, we get (remember the slope of the indifference line is in the interval  $[-1, 1]$ )

$$\text{sign} \left( \frac{d\pi_1}{da_1} \right) = \text{sign} \left( 4 - \frac{b_1 - b_2}{a_1 - a_2} \right) > 0 \quad (15)$$

$$\text{sign} \left( \frac{d\pi_1}{db_1} \right) = \text{sign} \left( \frac{2}{3(a_1 - a_2)} \right) > 0 \quad (16)$$

$$\text{sign} \left( \frac{d\pi_2}{da_2} \right) = \text{sign} \left( -2 - \frac{b_1 - b_2}{a_1 - a_2} \right) < 0 \quad (17)$$

$$\text{sign} \left( \frac{d\pi_2}{db_2} \right) = \text{sign} \left( \frac{2}{3(a_1 - a_2)} \right) > 0 \quad (18)$$



Therefore, firm 1 offers the highest quality in both characteristics.

$$a_1 = a_{\max} = \bar{c}, \quad b_1 = b_{\max} = \bar{c} \quad (19)$$

Contrary to firm 1, firm 2 offers the highest quality in characteristic  $b$ , but to avoid an outstanding wage competition it offers poor quality in characteristic  $a$  combined with a higher wage than firm 1.<sup>2</sup> Workers with a low valuation of quality in characteristic  $a$  will prefer to work in firm 2.

$$a_2 = a_{\min} = \underline{c}, \quad b_2 = b_{\max} = \bar{c} \quad (20)$$

Both equilibrium wages depend only on the productivity of the workers and on specification of characteristic  $a$ . Equilibrium wages, firms employment and profits are given below.

$$w_1 = p - \frac{2(\bar{c} - \underline{c})}{3}, \quad w_2 = p - \frac{(\bar{c} - \underline{c})}{3} \quad (21)$$

$$L_1 = \frac{2}{3} \quad \text{and} \quad L_2 = \frac{1}{3} \quad (22)$$

$$\pi_1 = \frac{4(\bar{c} - \underline{c})}{9} \quad \text{and} \quad \pi_2 = \frac{(\bar{c} - \underline{c})}{9} \quad (23)$$

Substituting the results into the indifference line, we get a horizontal line at  $t_a = \frac{1}{3}$ , so assumptions 1 to 3 are fulfilled.

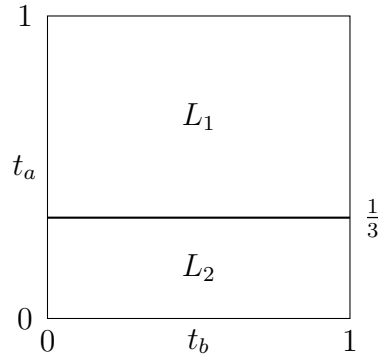


Figure 3: Equilibrium

Wages are differentiated, even though all workers have the same productivity. The solution is asymmetric, firm 1 offers higher quality (in one of the characteristics) and has to pay a lower wage. The wage difference depends on the maximal possible difference of quality  $(\bar{c} - \underline{c})$ .

Note that the social planner would set the highest qualities in both firms. The reason is that the overall employment is constant, thus only the utility gains from offering high quality matter.

We have to proof, if the equilibrium is a global one. Therefore we have to analyze situations where the indifference line intersects one of the horizontal boarder lines.

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<sup>2</sup>With the same qualities in both firms, wage competition will be high and the wage would rise up to the marginal product  $p$ , absorbing all profit.

**Case A1:** Indifference line intersects the left vertical and the lower horizontal boarder lines (see Figure 4). The slope of the indifference line has to be negative.  $w_2 > w_1$

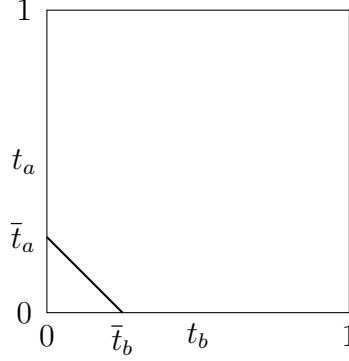


Figure 4: Case A1

$$\bar{t}_a = \frac{w_2 - w_1}{a_1 - a_2} \quad \text{and} \quad \bar{t}_b = \frac{w_2 - w_1}{b_1 - b_2} \quad (24)$$

$$L_2 = \frac{\bar{t}_a \bar{t}_b}{2} \quad (25)$$

$$w_1 = p - \frac{3\sqrt{2(a_1 - a_2)(b_1 - b_2)}}{4} \quad \text{and} \quad w_2 = p - \frac{\sqrt{2(a_1 - a_2)(b_1 - b_2)}}{4} \quad (26)$$

$$\frac{d\pi_1}{da_1} > 0 \quad \frac{d\pi_1}{db_1} > 0 \quad (27)$$

$$\frac{d\pi_2}{da_2} < 0 \quad \frac{d\pi_2}{db_2} < 0 \quad (28)$$

$$\Rightarrow a_1 = \bar{c}, \quad b_1 = \bar{c}, \quad a_2 = \underline{c}, \quad b_2 = \underline{c} \quad (29)$$

$$\pi_1^* = \frac{9\sqrt{2}}{16}(\bar{c} - \underline{c}) \quad \text{and} \quad \pi_2^* = \frac{\sqrt{2}}{16}(\bar{c} - \underline{c}) \quad (30)$$

Firm 1 selects the same strategy as in the main text. To determine the Nash equilibrium, we have to compare profit of firm 2 with the different strategies. Given our assumptions firm 2's profit is clearly higher with the *max-min* strategy, therefore constituting the equilibrium.

If the range of the characteristics is different and the range of the characteristic  $b$  is sufficient larger than that of characteristic  $a$ , that is  $b_{\max} - b_{\min} > 2(a_{\max} - a_{\min})$ , then firm 2 will choose the *min-min* strategy (see Vandenbosch and Weinberg 1995). A third type of equilibrium arise, if  $\frac{1}{2}(b_{\max} - b_{\min}) < a_{\max} - a_{\min} < \frac{81}{128}(b_{\max} - b_{\min})$ . The equilibrium locations will be  $a_1 = a_{\max}$ ,  $b_1 = b_{\max}$ ,  $a_2 = a_{\max} - \frac{1}{2}(b_{\max} - b_{\min})$ , and  $b_2 = b_{\max}$  in this case.

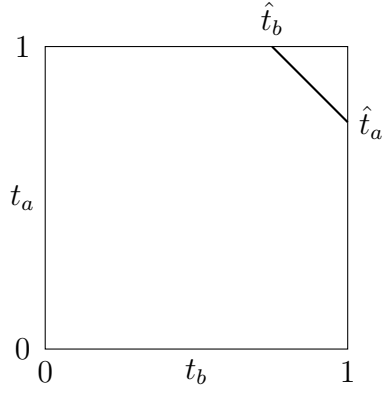


Figure 5: Case A2

**Case A2:** Indifference line intersects the upper horizontal and the right vertical boarder lines (see Figure 5). The slope of the indifference line has to be negative.  $w_2 > w_1$

$$\hat{t}_a = \frac{w_2 - w_1}{a_1 - a_2} - \frac{b_1 - b_2}{a_1 - a_2} \quad \text{and} \quad \hat{t}_b = \frac{w_2 - w_1}{b_1 - b_2} - \frac{a_1 - a_2}{b_1 - b_2} \quad (31)$$

$$L_1 = \frac{(1 - \hat{t}_a)(1 - \hat{t}_b)}{2} \quad (32)$$

$$\begin{aligned} w_1 &= p - \frac{\sqrt{(a_1 - a_2)^2 + (b_1 - b_2)^2 + 10(a_1 - a_2)(b_1 - b_2)}}{8} - \frac{(a_1 - a_2) + (b_1 - b_2)}{8} \\ w_2 &= p - \frac{3\sqrt{(a_1 - a_2)^2 + (b_1 - b_2)^2 + 10(a_1 - a_2)(b_1 - b_2)}}{8} + \frac{5((a_1 - a_2) + (b_1 - b_2))}{8} \end{aligned} \quad (33)$$

In this case,  $\hat{t}_a$  will not be in the interval  $[0,1]$  and no price equilibrium exists.

**Case A3:** Indifference line intersects the left vertical and the upper horizontal boarder lines (see Figure 6). The slope of the indifference line has to be positive.

$$\bar{t}_a = \frac{w_2 - w_1}{a_1 - a_2} \quad \text{and} \quad \hat{t}_b = \frac{w_2 - w_1}{b_1 - b_2} - \frac{a_1 - a_2}{b_1 - b_2} \quad (34)$$

for  $b_1 \neq b_2$ .

$$L_1 = \frac{(1 - \bar{t}_a)\hat{t}_b}{2} \quad (35)$$

$$\begin{aligned} w_1 &= p - \frac{a_1 - a_2}{8} - \frac{\sqrt{(a_1 - a_2)^2 - 8(a_1 - a_2)(b_1 - b_2)}}{8} \\ w_2 &= p + \frac{5(a_1 - a_2)}{8} - \frac{3\sqrt{(a_1 - a_2)^2 - 8(a_1 - a_2)(b_1 - b_2)}}{8} \end{aligned} \quad (36)$$

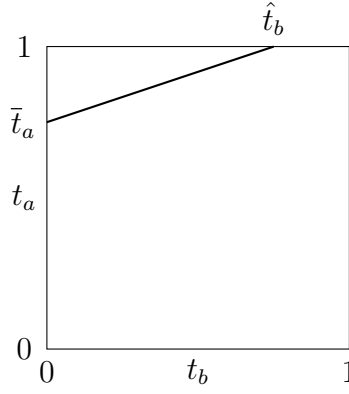


Figure 6: Case A3

Substituting equilibrium wages back into  $\hat{t}_b$ , we get value out of the interval  $[0,1]$  and no price equilibrium exists.

**Case A4:** Indifference line intersects the lower horizontal and the right vertical boarder lines (see Figure 7). The slope of the indifference line has to be positive.  $w_2 < w_1$  in this case.

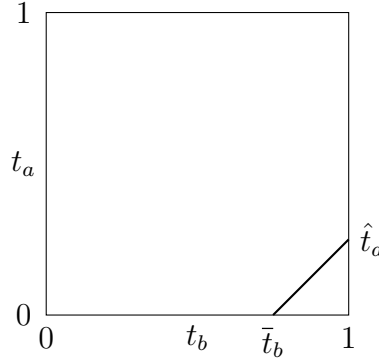


Figure 7: Case A4

$$\bar{t}_b = \frac{w_2 - w_1}{b_1 - b_2} \quad \text{and} \quad \hat{t}_a = \frac{w_2 - w_1}{a_1 - a_2} - \frac{b_1 - b_2}{a_1 - a_2} \quad (37)$$

for  $a_1 \neq a_2$ .

$$L_2 = \frac{(1 - \bar{t}_b)\hat{t}_a}{2} \quad (38)$$

$$\begin{aligned} w_1 &= p - \frac{5(b_1 - b_2)}{8} - \frac{3\sqrt{(b_1 - b_2)^2 - 8(a_1 - a_2)(b_1 - b_2)}}{8} \\ w_2 &= p + \frac{b_1 - b_2}{8} - \frac{\sqrt{(b_1 - b_2)^2 - 8(a_1 - a_2)(b_1 - b_2)}}{8} \end{aligned} \quad (39)$$

Substituting equilibrium wages back into  $\bar{t}_b$ , we get value out of the interval  $[0,1]$  and no price equilibrium exists.

## 3 Empirical Investigation

### 3.1 Data and Method

**Data** We make use of the Workplace Employment Relations Survey (WERS) 2004 for our empirical investigation<sup>3</sup>. WERS is a comprehensive survey on establishment or workplace level and covers both private and public sectors<sup>4</sup>. It comprises around 2300 workplaces, 1000 employee representatives and 22500 employees<sup>5</sup>. The advantage of this dataset for our purposes is the selection of up to 25 employees in each workplace, thus very advantageous for a convincing statistical test on firm and (UK SIC2003) subclass level respectively. In contrast to our quantitative derivation of the results in section 2 the variables we use here are qualitative. Thus they can be measured only on a nominal or ordinal basis. Furthermore we do not rely on objective measures of working conditions, but rather subjective perceptions about job characteristics in the WERS.

**Method** To check our theoretical hypothesis we use firms of 29 subclasses following the UK Standard Industry Classification 2003 (UK SIC(2003)). Subclasses were selected due to similarity of the produced goods and furthermore in which subclasses most individuals were interviewed<sup>6</sup>. From these selected employees we highlight questions about the satisfaction of the employees with some characteristics of their jobs. These variables comprise for example satisfaction with training or job security. In what follows for reasons of convenience we use only abbreviations of the variables investigated, these are: ACHIEVEMENT, INITIATIVE, INFLUENCE, TRAINING, SATPAY, SECURITY and WORK<sup>7</sup>. Due to strong correlation among the chosen variables, factor analysis was required to reduce their number. We found that ACHIEVEMENT, INFLUENCE, INITIATIVE and WORK can be grouped together into one variable (in the following “F1”), similarly TRAINING and JOB SECURITY (in the following “F2”). As a result we finally get 2 variables (F1, F2) and SATPAY<sup>8</sup>. After merging variables to factors we apply non-parametric Mann-Whitney tests to investigate if job characteristics are different between subclasses or not<sup>9</sup>.

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<sup>3</sup>WERS is a survey for the Department of Trade and Industry (DTI), the Economic and Social Research Council (ESRC), the Advisory, Conciliation and Arbitration Service (Acas) and the Policy Studies Institute(PSI).

<sup>4</sup>It covers all workplaces with  $\geq 5$  employees in Great Britain engaged in activities within sectors D to O of the UK Standard Industry Classification 2003 (UK SIC(2003)).

<sup>5</sup>The survey contains a questionnaire to employees, managers and employee representatives.

<sup>6</sup>See Appendix A.1 for a detailed description of the selected subclasses.

<sup>7</sup>For a detailed list with the questionnaire see Appendix A.2.

<sup>8</sup>SATPAY (satisfaction with pay) has to be interpreted as a compensation for non-wage job characteristics (here F1 and F2). If workers are satisfied with their wage, wages are (subjective) overly compensating for either good or bad working conditions.

<sup>9</sup>A Mann-Whitney test is a nonparametric test to verify if two samples originate from the same population or not. There is no a priori assumption about the distribution of the population. See for a good introduction (Noether 1991).

### 3.2 Results

Table 5 in Appendix A.3 reports results of one-sided Mann-Whitney tests for job characteristics. We compared every pair of subclasses within every group considered. In the following we use the abbreviations MAIN for the  $[max-max, max-min]$  equilibrium and SEC for the  $[max-max, min-min]$  equilibrium. In Table 1 results for group “Production, processing and preserving of meat and meat products” are presented<sup>10</sup>.

	F1	F2	WAGE	SATPAY
(11) Meat-production & processing	*	*		
(12) Poultry-production & processing				
(11) Meat-production & processing		**	**	
(13) Meat & poultry products				
(11) Meat-production & processing				
(14) Meat & poultry processing				
(12) Poultry-production & processing	**	***	**	**
(13) Meat & poultry products				
(12) Poultry-production & processing	*	**		***
(14) Meat & poultry processing				
(13) Meat & poultry products		***	***	
(14) Meat & poultry processing				

Table 1: One-sided Mann-Whitney test for subclasses in the group “Production, processing and preserving of meat and meat products” (\* 10%, \*\* 5% and \*\*\* 1% level)

F1 and F2 are the grouped variables due to factor analysis. “SATPAY” means subjective satisfaction with remuneration and “WAGE” is the objective amount of the hourly wage employees receive<sup>11</sup>. Greyshaded cells with stars signify that employees in the second subclass are significantly more satisfied with one job characteristic than employees in the first subclass. White cells with stars have to be interpreted vice versa. One can see that only two comparisons of subclasses conform with our theoretical predictions for case MAIN. Meat-producing and processing (11) and meat and poultry processing firms (14) offer higher wages but less training and job security versus meat and poultry-products producing firms (13). Case SEC is found for poultry-production and processing (12) versus meat and poultry products (13). Here wages are higher in poultry production but employees have better job characteristics in meat and poultry products. SATPAY in this comparison means that workers in (13) are more satisfied with their wage than in (12). That is workers in (13) regard their wages high enough to compensate for their good working conditions. The other comparisons show no unique confirmation of our theoretical results.

The second group we consider in detail is “Manufacture of other food products”.

What we can deduce from Table 2 is that workers in subclass “Sugar confectionery” (34) get higher wages than in all other subclasses, but are more dissatisfied with training and job security than in other subclasses except (35) “Other foods not classified elsewhere”. Thus case MAIN can be found for the pairs 31/34, 32/34 and 33/34. Case SEC is not existent in this group.

<sup>10</sup>The numbers in parenthesis in the first column refer to our own classification, see Appendix A.3.

<sup>11</sup>It is worthwhile to mention that wages are only measured on an ordinal scale, see Appendix A.2.

	F1	F2	WAGE	SATPAY
(31) Bread, fresh pastry goods and cakes		**		*
(32) Rusks and biscuits, preserved pastry goods and cakes				
(31) Bread, fresh pastry goods and cakes		*		
(33) Cocoa and chocolate confectionery				
(31) Bread, fresh pastry goods and cakes		**	***	*
(34) Sugar confectionery				
(31) Bread, fresh pastry goods and cakes				
(35) Other food products not elsewhere classified				
(32) Rusks and biscuits, preserved pastry goods and cakes			*	
(33) Cocoa and chocolate confectionery				
(32) Rusks and biscuits, preserved pastry goods and cakes		***	***	
(34) Sugar confectionery				
(32) Rusks and biscuits, preserved pastry goods and cakes		**		
(35) Other food products not elsewhere classified				
(33) Cocoa and chocolate confectionery		***	***	
(34) Sugar confectionery				
(33) Cocoa and chocolate confectionery		**		
(35) Other food products not elsewhere classified				
(34) Sugar confectionery			***	
(35) Other food products not elsewhere classified				

Table 2: One-sided Mann-Whitney test for subclasses in the group “Manufacture of other food products” (\* 10%, \*\* 5% and \*\*\* 1% level)

The last group considered in detail is human health activities. In Table 3 we compare the three subclasses public and private hospitals and medical nursing home activities.

	F1	F2	WAGE	SATPAY
(91) Public sector hospital activities	***	**	**	**
(92) Private sector hospital activities				
(91) Public sector hospital activities	***	***	***	
(93) Medical nursing home activities				
(92) Private sector hospital activities		**	***	***
(93) Medical nursing home activities				

Table 3: One-sided Mann-Whitney test for subclasses in the group “Human health activities” (\* 10%, \*\* 5% and \*\*\* 1% level)

Employees in subclass (93) “Medical nursing home activities” get higher wages than in public (91) and private hospitals (92) but less training and job security<sup>12</sup>. Additionally they are more satisfied with their pay than employees in private hospitals, hence we can deduce that the remuneration WAGE is enough, roughly speaking, to compensate for worse training opportunities and job security (F2). Employees in public hospitals are more satisfied with job characteristics F1 and F2 than those in private hospitals but get lower wages. Employees in public hospitals are more satisfied with their pay than employees in private hospitals, which may indicate, that employees in public hospitals

<sup>12</sup>Our results for private versus public hospitals are consistent with the result of Almond and Kendall (2000) comparing non-profit versus for-profit/government sectors as mentioned in the Introduction.

are compensated by job characteristics F1 and F2 for lower wages. According to our model, public hospitals should offer better job amenities due to worse remuneration. Private hospitals offer better training and job security prospects while paying less than medical nursing home activities. Thus case MAIN seem to apply to private hospitals versus medical nursing home activities. Case SEC can be found for private versus public hospitals and public hospitals versus medical nursing home activities. Additionally a parametric t-test indicates that employees in public hospitals are more satisfied with ACHIEVE, INFLUENCE, INITIATIVE and WORK (=F1) on an 1%-level of significance than in private hospitals, no significant difference in SECURITY and TRAINING (=F2) but employees in public hospitals get less paid. Thus, a parametric t-test verifies the expected theoretical result: public and private hospitals compete in WAGE and one job characteristic (=F1), while TRAINING and SECURITY seem to be very similar. Hence with parametric testing case MAIN are also found for private versus public hospitals.

Based on these test, confirmation of our theoretical results can be found in some subclasses. Referring to Table 5, 7 out of 37 comparisons between subclasses confirm our results for case MAIN, 4 out of 37 comparisons case SEC and no differentiation of job characteristics occur in 14 comparisons<sup>13</sup>. Differentiation in at least one job characteristic but no compensation by a different wage can be found in 12 comparisons.

## 4 Conclusions

In this paper firms offer jobs with two non-wage characteristics. Both characteristics are vertically differentiated, that means that in the view of all potential workers there exists an optimal specification (qualities) of a job. Firms can offer high quality with no costs. Workers differ in their willingness to substitute these qualities for wage. In equilibrium firms offer differentiated jobs to discriminate between workers who call for high quality and workers who are willing to accept lower quality in exchange for higher wages. Wages will be differentiated although all workers have the same productivity in both firms and, as usual in oligopsonistic markets, wages will be lower than in a competitive labour market.

If the non-wage characteristics are symmetrical in some sense (if the intervals within the two characteristics lie is the same for both characteristics), then one firm will offer jobs with highest quality in both characteristics and the competing firm will offer jobs with highest quality in one and lowest quality in the other characteristic. Firms will differentiate in one characteristic only. The old idea of minimal differentiation (Hotelling 1929) will be valid in this model at least in one of the characteristics. But firms try to avoid wage competition and one of the characteristics is differentiated maximal for that reason. The solution a social planer would prefer, highest quality in both characteristics, is no equilibrium.

Empirically we use the dataset WERS (Workplace Employment Relations Survey), an employee-employer data. We use job characteristics measured on an ordinal, subjective basis. By comparing (UK SIC2003) subclasses and using a Mann-Whitney-Test to test for differences in offered job characteristics between subclasses we found evidence that firms do indeed compete in non-wage characteristics in order to retain and attract employees.

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<sup>13</sup>3 out of these 14 comparisons show that firms offer the same job characteristics but firms in the respective subclasses offer different wages.



In some sectors firms compete in one job characteristic only, as our simple theory predicts.

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## Appendix A

### A.1 Selected subclasses

Table 4 gives an overview about the treated subclasses. The first column indicates a number for the group to which classes or subclasses (column 2) belong<sup>14</sup>. Column 3 indicates our own numbers for classes and subclasses beginning with 11 (group 1, (sub)class 1) and ending with 93 (group 9, (sub)class 3). The last column describes the detailed activity of a (sub)class. As variables we used the wage income per hour and the satisfaction of employees concerning some job characteristics.

### A.2 Variables

The questions were taken out of WERS (number A8 and E15), the employee questionnaire. The first question is about satisfaction of employees about job characteristics, the second question about hourly wage rate.

How satisfied are you with the following aspects of your job?

- The sense of achievement you get from your work (ACHIEVE)
- The scope for using your own initiative (INITIATIVE)
- The amount of influence you have over your job (INFLUENCE)
- The training you receive (TRAINING)
- The amount of pay you receive (SATPAY)
- Your job security (SECURITY)
- The work itself (WORK)

Shortcuts used in the text are indicated in parenthesis.

It would be helpful if you could also tell us about your hourly pay. How much do you get paid per hour, before tax and other deductions are taken out?

- £4.50 or less per hour
- £4.50-£5.00 per hour
- £5.01-£14.99 per hour
- £15.00 or more per hour

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<sup>14</sup>DA, DE etc in column 2 refers to the subsections to which the group belongs to, e.g. DA is a subsection of section D (“Manufacture”) and stands for “Manufacture of Food Products, Beverages and Tobacco”

	SIC (2003)	Our classification	Name of subclass
1	DA 15.11/1	11	Slaughtering of animals other than poultry and rabbits
	DA 15.11/2	12	Animal by-product processing
	DA 15.12	13	Production and preserving of poultry meat
	DA 15.13/9	14	Other meat and poultry meat processing
2	DA 15.61/1	21	Grain milling
	DA 15.61/2	22	Manufacture of breakfast cereals and cereals-based foods
3	DA 15.81	31	Bread, fresh pastry goods and cakes
	DA 15.82	32	Rusks and biscuits, preserved pastry goods and cakes
	DA 15.84/1	33	Manufacture of cocoa and chocolate confectionery
	DA 15.84/2	34	Manufacture of sugar confectionery
	DA 15.89/9	35	Manufacture of other food products not elsewhere classified
4	DE 22.12	41	Publishing of newspaper
	DE 22.13	42	Publishing of journals and periodicals
5	DH 25.21	51	Manufacture of plastic plates, sheets, tubes and profiles
	DH 25.22	52	Manufacture of plastic packing goods
	DH 25.23	53	Manufacture of builders' ware of plastic
	DH 25.24	54	Manufacture of other plastic products
6	DK 29.22	61	Manufacture of lifting and handling equipment
	DK 29.23	62	Manufacture of non-domestic cooling and ventilation equipment
	DK 29.24	63	Manufacture of other general purpose machinery not elsewhere classified
7	DL 32.20/1	71	Manufacture of telegraph and telephone apparatus and equipment
	DL 32.20/2	72	Manufacture of radio and electronic capital goods
8	DN 36.11	81	Manufacture of chairs and seats
	DN 36.12	82	Manufacture of other office and shop furniture
	DN 36.13	83	Manufacture of other kitchen furniture
	DN 36.14	84	Manufacture of other furniture
9	N 85.11/1	91	Public sector hospital activities, including NHS Trusts
	N 85.11/2	92	Private sector hospital activities
	N 85.11/3	93	Medical nursing home activities

Table 4: Overview of subclasses used

### A.3 Results

Greyshaded cells with stars have to be interpreted as a significant higher satisfaction regarding a particular job characteristic in the second subclass and entries with no shaded areas vice versa. F1 and F2 are grouped satisfaction variables due to factor analysis. F1 combines ACHIEVE, INITIATIVE, INFLUENCE and WORK, F2 TRAINING and SECURITY. WAGE is the hourly wage measured on an ordinal scale. SATPAY is satisfaction of the employees with their remuneration. Numbers in the first column refer to our classification defined in Appendix A.1.

	F1	F2	WAGE	SATPAY
11/12	*	*		
11/13		**	**	
11/14				
12/13	**	***	**	**
12/14	*	**		***
13/14		***	***	
21/22			***	**
31/32		**		*
31/33		*		
31/34		**	***	*
31/35				
32/33			*	
32/34		***	***	
32/35		**		
33/34		***	***	
33/35		**		
34/35			***	
41/42				
51/52				
51/53			***	
51/54				
52/53		**	***	
52/54				
53/54	*	**	***	
61/62	**	*		*
61/63	***	***		**
62/63	**	***		**
71/72		**		**
81/82				**
81/83				
81/84	*			*
82/83				*
82/84				
83/84	*	*		
91/92	***	**	**	**
91/93	***	***	***	
92/93		**	***	***

Table 5: Mann-Whitney test for differences in job characteristics (\* 10%, \*\* 5% and \*\*\* 1% level)

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